presence of both oxygen and nitrous oxide at a combined flow rate in the range of about 1500 sccm to about 2500 sccm. The resulting film is consistently smooth and has good step coverage. The present invention employs nitrous oxide (N_2O) and oxygen flowing at a predetermined high rate during the CVD process to control the deposition rate and the step coverage of the platinum group metal.

The present invention further provides a method for depositing a platinum metal on a substrate which includes the steps of flowing a gas having saturated therein a platinum precursor over the substrate with a temperature of about 200 °C to about 300 °C in the presence of both oxygen (O_2) and nitrous oxide (N_2O). The selected operating temperature is a temperature at which the platinum group metal deposits on the substrate, but less than a temperature at which the platinum group metal fails to smoothly deposit on the substrate. The time at which the process operates, of about 45 seconds to about 1000 seconds, is a deposition time at which the platinum group metal will deposit on the substrate in a continuous film while maintaining good step coverage. Most importantly, because the combined flow rate of oxygen and nitrous oxide is very high, a smooth film with a good step coverage is unexpectedly obtained.

More specifically, claims 56, 61 and 66 recite a method for depositing a platinum group metal on a substrate, which includes depositing said platinum group metal onto a substrate in a CVD deposition chamber in the presence of both oxygen and nitrous oxide at a predetermined ratio with a "combined flow rate in the range of about 1500 sccm to about 2500 sccm" and at "a predetermined temperature of from about 200°C to about 300°C." Dependent claims 57, 62 as well as independent claim 66 further recite that the

predetermined deposition time is of about 45 seconds to about 1000 seconds. Dependent claim 58, 63 and 68 further recite that the deposition time is preferably of about 75 seconds to about 150 seconds. These conditions are not disclosed or suggested by Baum et al. ("Baum").

Baum relates to a liquid delivery for the transport of a platinum source reagent to a CVD reactor using a source reagent liquid solution which is volatilized to provide a vapor phase platinum source material for subsequent deposition from the vapor in the CVD reactor of platinum. Baum recites that the liquid solution precursor may optionally comprise an oxidizing gas such as oxygen, ozone, nitrous oxide and mixtures thereof in a platinum CVD deposition process. (Col. 5, lines 13-27). Baum is silent as to the operating conditions of the liquid delivery apparatus to be used in a CVD process other than to recite that the liquid delivery eliminates "the deleterious effects of having oxygen in contact with capacitor oxides at high temperatures (i.e., ≥500°C)." (Col. 5, lines 1-3).

Baum is completely silent as to the total flow rate at which both oxygen and nitrous oxide are introduced into the chamber and the deposition time. To overcome this shortcoming, the Office Action states that "the flow rate of oxidizing gases to the chamber is a result effective parameter and it would have been a matter of routine experimentation to determine appropriate . . . flow rates." Office Action at 2. The Office Action then asserts that, although "Baum et al. are silent as to the deposition times and Pt film thicknesses . . . these parameters are clearly related and the thickness is a function of the intended purpose." Office Action at 2. The Office Action concludes that "adjustment of

these result effective parameters through routine experimentation would have been obvious." Office Action at 2-3.

The total flow rate of oxygen and nitrous oxide as recited by claims 56, 61 and 66 is not a result effective parameter. In In re Waymouth, 499 F.2d 1273, 1276, 182 USPQ 290, 293 (CCPA 1974), the court of appeals held that unexpected results for a claimed range as compared with the range disclosed in the prior art had been shown by a demonstration of "a marked improvement, over the results achieved under other ratios." Evidence of unobvious or unexpected advantageous properties, such as superiority in a property the claimed compound shares with the prior art can rebut prima facie obviousness." In re Chupp, 816 F.2d 643, 646, 2 USPQ2d 1437, 1439 (Fed. Cir. 1987). Accordingly, a specific ratio of halogen to mercury for producing whiter light by a lamp was held by the Court to be "critical" for attainment of maximum white light emission, and the claimed ratio was not the result of obvious experimentation. In re Waymouth, 499 F.2d at 1276.

In deposition processes of the semiconductor industry, increasing the flow rate of one oxidizing gas decreases at one point the step coverage mainly because the precursor gas becomes diluted. For example, during the deposition of titanium nitride (TiN), a flow carrier gas, such as helium (He), is flown in a bubbler over tetrakisdimethyl amido-titanium (TD mat) gas precursor. At the beginning of the deposition process, as the flow rate of the carrier gas increases, the deposition rate of TiN and its step coverage increase accordingly. However, at some point during the deposition process, too much carrier gas adversely

affects the deposition rate of TiN and the step coverage because the TD mat precursor gas becomes diluted.

Similarly, when argon (Ar) and oxygen (O_2) come into contact with a metal containing gas, such as a platinum containing gas for platinum deposition, there is always a danger of increasing the flow rates of argon and oxygen to the point where the metal containing gas does not become diluted. Further, an increased flow rate of oxygen is well-known to give higher growth and deposition rates.

In the present invention, the total flow rate of oxygen and nitrous oxide is extremely high compared to the flow rates of the prior art. As illustrated in Examples 1-4 of the Application, this combined flow rate, in a range of about 1500 sccm to about 2500 sccm, results in a continuous and smooth platinum film. More importantly, the smooth and continuous platinum film has unexpected good coverage, up to 69%, "a marked improvement" over the results achieved under the prior art. (Application at 17). As explained above, these results are unexpected because increasing the flow rate of carrier gases typically results in the dilution of the precursor gas and thus in poor step coverage and poor film qualities. Accordingly, the claimed total ratio of the present invention is not a mere result of routine or obvious experimentation, as recognized by the Court in In re Waymouth.

Claims 61-68 stand rejected under 35 U.S.C. § 103 as being unpatentable over Baum in view of Kwon et al. ("Kwon"). This rejection is respectfully traversed.

Kwon does not disclose or suggest that the platinum deposition be conducted in the presence of oxygen and nitrous oxide as claims 61-68 recite. Furthermore, Kwon does not teach or disclose a "a total flow rate [of oxygen and nitrous oxide] in the range of about 1500 sccm to about 2500 sccm," as independent claims 61 and 66 recite.

Thus, the combined teachings of Baum and Kwon still fail to disclose or suggest that the CVD deposition method be performed with oxygen and nitrous oxide at a total flow rate "in the range of about 1500 sccm to about 2500 sccm," as recited in independent claims 61 and 66. There is nothing in this combination of references, without the improper use of hindsight reconstruction, to motivate the person having ordinary skill in the art to arrive at the instantly claimed method. Accordingly the subject matter defined by the claims 61-68 is not rendered obvious from the combined teachings of Baum and Kwon.

Claims 1-4, 6-10, 12-36, and 46-55 stand rejected under 35 U.S.C. § 103 as being unpatentable over Baum in view of Kwon and Chen et al. (Applied Physics Letters). This rejection is respectfully traversed.

Claims 1, 6 and 25 recite a method for depositing a platinum group metal on a substrate, which includes depositing said platinum group metal in a CVD deposition chamber in the presence of both oxygen and nitrous oxide at a predetermined ratio with a combined total flow rate in the range of about 1500 sccm to about 2500 sccm, at a pressure of about 10 to about 1000 Torr. Dependent claims 46 and 52 further recite a pressure of about 10 Torr to about 50 Torr, . Moreover, independent claim 25, as well as

dependent claims 4 and 10 recite a deposition temperature of about 200 °C to about 600 °C.

The Office Action concedes that Baum does not disclose a pressure. Nevertheless, to overcome the shortcoming of Baum, the Office Action relies upon Kwon, which teaches a pressure of 2 Torr in the CVD deposition of platinum, and upon Chen et al. ("Chen"), which teaches platinum deposition at 760 Torr (atmospheric pressure). In this respect, the Office Action concludes that "it would have been obvious to have used deposition pressures in this range (2 Torr to atmospheric (760 Torr)) which overlaps with the claimed ranges because these deposition pressures would have been expected to be effective for depositing the platinum films by CVD with these precursors." (Office Action at 6).

The claimed invention is not obvious over Baum in view of Kwon and Chen. First, Baum is silent as to the operating pressure of the CVD apparatus. Second, even if Kwon recites a deposition pressure of 2 Torr, Kwon does not disclose or suggest that the platinum deposition be conducted in the presence of oxygen and nitrous oxide as presently claimed. Thus, even if Kwon might suggest a platinum deposition at a pressure within the claimed range, Kwon still does not suggest the claimed chemistry, which is the mixture of oxygen and nitrous oxide at a very high flow rate, of about 1500 sccm to about 2500 sccm, or that the pressure used in Kwon would be applicable to the claimed chemistry. Third, Kwon does not teach or disclose a pressure other than 2 Torr. There is nothing to indicate that Kwon's 2 Torr pressure would be appropriate for a deposition chemistry which includes oxygen and nitrous oxide.

Similarly, Chen recites a deposition pressure of 760 Torr, but does not disclose or even suggest that the platinum deposition be effectuated in the presence of oxygen and nitrous oxide. Chen is also silent about the total flow rate in the range of about 1500 sccm to about 2500 sccm, as independent claims 1, 6 and 25 recite. In fact, Chen teaches a completely different mixture, that is flowing argon and hydrogen over a hot substrate. Further, Chen does not teach or disclose a pressure other than the atmospheric pressure and, again, Chen does not suggest that his pressure could be used with the specifically claimed chemistry. Thus, although Kwon and Chen arguably teach platinum deposition at very specific pressures, it is clear that Kwon and Chen do not teach or suggest that such pressures or any other pressure would be at all useful with the claimed chemistry.

Moreover, Kwon and Chen disclose entirely different chemistries from that employed in Baum. As such, there is no teaching or suggestion in any of these references for the claimed subject matter. The references are simply not combinable in view of the diverse chemistries involved in each reference. It is clear, therefore, that the rejection is based on picking and choosing selected portions of each reference, without regard to the totality of teachings of the references, in an attempt to improperly use hindsight to reconstruct the invention. Accordingly, a person of ordinary skill in the art would not have been motivated to combine Baum with Kwon and Chen, and withdrawal of this rejection is respectfully requested.

Furthermore, Kwon does not suggest or disclose a deposition pressure other than a low pressure such as 2 Torr. Kwon addresses the dependency between the microstructure and electrical properties of platinum films on one hand, and the various

deposition conditions, such as temperature, on the other hand. Kwon analyses the impact of only two deposition parameters (temperature and oxygen flow rates) on the nucleation and growth rates of platinum films. For example, according to Kwon, at a 50 sccm oxygen flow rate, "[P]latinum films deposited at 300 and 350°C showed a random orientation, but above 400°C the preferred orientation was (111)." (Kwon at 3). With respect to pressure, Kwon mentions only once that "the Pt source was vaporized at reduced pressure (2 Torr). (Kwon at 1). Kwon is silent on the impact, if any, that different pressures would have on the Pt film properties. More important, Kwon is silent on whether any variation in the deposition pressure could have any effect on the nucleation and growth rates of the Pt film. Thus, Kwon does not disclose or even suggest in any way a range of deposition pressures for which Kwon's experimental data would be valid.

Similarly, Chen does not disclose or suggest a deposition pressure other than 760 Torr (atmospheric pressure). Chen analyses only the impact of low temperatures on an atmosphere of hydrogen on the deposition of polycrystalline films of platinum. The experiment in Chen involves using toluene instead of benzene as the solvent, with the reaction starting at - 77°C and the substrate being held at 180°C. Chen mentions that "[T]he complex was vaporized at atmospheric pressure and 25°C into a stream of flowing argon." Atmospheric pressure and a temperature of 25-27°C are standard conditions, however, and Chen does not suggest in any range of pressure, and certainly not a lower than 760 Torr pressure that would work with low temperature and toluene, and not the conventional benzene as solvent. Chen is silent on any range of very low pressures, such as

a range including a pressure of 2 Torr. Thus, Kwon and Chen together do not suggest any range for the deposition pressure, and certainly not a range of 2 Torr to 760 Torr.

Thus, Baum in view of Kwon and Chen does not teach or suggest the CVD deposition in the presence of oxygen and nitrous oxide "at a pressure of from about 10 to about 1000 Torr" (claims 1, 6 and 25). Accordingly, claims 1-4, 6-10, 12-36 and 46-55 are patentable over Baum in view of Kwon and Chen.

Claims 1-4, 6-10, 12-36 and 46-55 stand rejected under 35 U.S.C. § 103 as being unpatentable over Kwon in view of Baum and Chen. This rejection is respectfully traversed.

Kwon teaches a pressure of 2 Torr in the CVD deposition of platinum by bubbling argon over a platinum precursor. As conceded by the Office Action, Kwon does not disclose or suggest that the platinum deposition be conducted in the presence of oxygen and nitrous oxide at a total flow rate in the range of about 1500 sccm to about 2500 sccm as presently claimed. Furthermore, Kwon does not teach or disclose a pressure other than 2 Torr. Nevertheless, to overcome this shortcoming in Kwon, the Office Action relies upon Baum to teach a mixture of oxidizing agents which may include oxygen and nitrous oxide. However, Baum does not suggest in any way how to modify Kwon, because, inter alia, Baum is completely silent on the deposition pressure and uses a different chemistry. The Office Action also relies on Chen to teach a platinum deposition at atmospheric pressure (760 Torr). But, Chen is not concerned with any variation in the deposition pressure and his chemistry is different from those of Baum and Kwon. As

explained above, Chen merely lists the 760 Torr pressure, along with the room temperature of 25°C, as standard operating parameters. There is nothing in Chen to even suggest that a low pressure may, or could, work with toluene as solvent under a very low temperature of -77°C. Thus, Baum and Chen do not disclose or suggest how to modify Kwon to attain the claimed invention.

In sum, there is nothing in this combination of references, without the improper use of hindsight reconstruction, to motivate a person having ordinary skill in the art to arrive at the claimed method.

In view of the foregoing remarks, each of the presently pending claims in this application is believed to be in immediate condition for allowance. Accordingly, the Examiner is respectfully requested to withdraw the outstanding rejection of the claims and to pass this application to issue.

Dated: July 14, 2000

Respectfully submitted,

By_____

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